

WHAT IS CLAIMED IS:

1. A method of comparing an input pattern with a memory pattern comprising the steps of:

loading a representation of said input pattern into cells in an input layer;

loading a representation of said memory pattern into cells in a memory layer;

loading an initial value into cells in an intermediate layers between said input layer and said memory layer;

comparing values of cells in said intermediate layers with values stored in cells of adjacent layers including calculating a minimum energy connection in curved space from said cell in said intermediate layer to said cells in said intermediate layers;

updating values stored in cells in said intermediate layers based on said step of comparing; and

mapping cells in said memory layer to cells in said input layer.

2. The method of claim 1 wherein said curved space is defined in Riemmanian geometry.

3. The method of claim 1 wherein the minimum energy is written as:

$$\left(K_1 P_i P^i + K_2 \left(\frac{(P_r;_s - P_s;_r)(P_L;_k - P_k;_L) g^{rl} P^s P^k}{P^i P_i} + \frac{(P^\lambda P_\lambda),_m (P^s P_s),_k g^{mk}}{P^i P_i} \right) + K_3 \left(\frac{(P^\lambda P_\lambda),_m P^m}{P^i P_i} \right)^2 + K_4 R \right) \sqrt{\pm g}$$

where: g is the determinant of the metric tensor, upper indices denote contravariant tensor property, lower indices denote covariant tensor properties, P_i denotes a gradient $P_i \equiv \frac{\partial P}{\partial x^i}$ of a gradually changing function P , that changes between the memory and input layers, $(-d < x^1 < d, -d < x^2 < d, \dots, -d < x^n < d)$,

$(-d < x^1 < d, -d < x^2 < d, \dots, x^j + \delta, \dots, -d < x^n < d)$ (when n is the dimension of a Riemannian manifold and $d > 0$ is a very large in relation to $\delta > 0$), semi colon denotes a covariant derivative and comma denotes an ordinary derivative, $P_{i,j} \equiv \frac{\partial P_i}{\partial x^j}$. R denotes the scalar curvature also known as Ricci scalar, and K_1, K_2, K_3, K_4 denote constants of the model.

4. The method of claim 1 further including a step of:
ascertaining said representation of said input pattern by preprocessing said input pattern.
5. The method of claim 1 further including a step of:
ascertaining said representation of said memory pattern by preprocessing said memory pattern.
6. The method of claim 1 wherein at least one of said initial values loaded into said cells in said intermediate layers are identical to said representation of said input pattern.
7. The method of claim 1 wherein at least one of said initial values loaded into said cells in said intermediate layers are identical to said representation of said memory pattern.
8. The method of claim 1 wherein said step of comparison includes comparing said value in said cell with values in three adjacent cells in said adjacent layer.
9. The method of claim 1 wherein said step of comparison includes calculating a distance in curved space from said cell in said intermediate layer to said cells in said intermediate layers.

10. The method of claim 1 wherein said step of mapping cells includes the steps of:

introducing a vibration wave into a cell of said input layer.

11. A method of comparing an input pattern with a memory pattern comprising the steps of:

loading a representation of said input pattern into cells in an input layer;

loading a representation of said memory pattern into cells in a memory layer;

loading an initial value into cells in an intermediate layers between said input layer and said memory layer;

comparing values of cells in said intermediate layers with values stored in cells of adjacent layers through curved space;

updating values stored in cells in said intermediate layers based on said step of comparing; and

mapping cells in said memory layer to cells in said input layer including introducing a vibration wave into a cell of said input layer

12. The method of claim 11 wherein said curved space is defined in Riemmanian geometry.

13. The method of claim 11 wherein said step of comparing includes a step of calculating a minimum energy connection in said curved space from said cells in said intermediate layer to said cells in said intermediate layers.

14. The method of claim 13 wherein the minimum energy is written as:

$$\left. \begin{aligned} & K_1 P_i P^i + \\ & K_2 \left(\frac{(P_r;_s - P_s;_r)(P_L;_k - P_k;_L) g^{rl} P^s P^k}{P^i P_i} + \frac{(P^l P_\lambda),_m (P^s P_s),_k g^{mk}}{P^i P_i} \right) + \\ & K_3 \left(\frac{(P^l P_\lambda),_m P^m}{P^i P_i} \right)^2 + \\ & K_4 R \end{aligned} \right\} \sqrt{\pm g}$$

where: g is the determinant of the metric tensor, upper indices denote contravariant tensor property, lower indices denote covariant tensor properties, P_i denotes a gradient $P_i \equiv \frac{\partial P}{\partial x^i}$ of a gradually changing function P , that changes between the memory and input layers, $(-d < x^1 < d, -d < x^2 < d, \dots, -d < x^n < d)$, $(-d < x^1 < d, -d < x^2 < d, \dots, x^j + \delta, \dots, -d < x^n < d)$ (when n is the dimension of a Riemannian manifold and $d > 0$ is a very large in relation to $\delta > 0$), semi colon denotes a covariant derivative and comma denotes an ordinary derivative, $P_{i,j} \equiv \frac{\partial P_i}{\partial x^j}$. R denotes the scalar curvature also known as Ricci scalar, and K_1, K_2, K_3, K_4 denote constants of the model.

15. The method of claim 11 further including a step of:
ascertaining said representation of said input pattern by preprocessing said input pattern.
16. The method of claim 11 further including a step of:
ascertaining said representation of said memory pattern by preprocessing said memory pattern.
17. The method of claim 11 wherein at least one of said initial values loaded into said cells in said intermediate layers are identical to said representation of said input pattern.
18. The method of claim 11 wherein at least one of said initial values loaded into said cells in said intermediate layers are identical to said representation of said memory pattern.
19. The method of claim 11 wherein said step of comparison includes comparing said value in said cell with values in three adjacent cells in said adjacent layer.

20. The method of claim 11 wherein said step of comparison includes calculating a distance in curved space from said cell in said intermediate layer to said cells in said intermediate layers.

21. An apparatus for comparing an input pattern with a memory pattern, the apparatus comprising:

means for loading a representation of said input pattern into cells in an input layer;

means for loading a representation of said memory pattern into cells in a memory layer;

means for loading an initial value into cells in an intermediate layers between said input layer and said memory layer;

means for comparing values of cells in said intermediate layers with values stored in cells of adjacent layers including calculating a minimum energy connection in curved space from said cell in said intermediate layer to said cells in said intermediate layers;

means for updating values stored in cells in said intermediate layers based on said step of comparing; and

means for mapping cells in said memory layer to cells in said input layer.

22. The apparatus of claim 21 wherein said curved space is defined in Riemmanian geometry.

23. The method of claim 21 wherein the minimum energy is written as:

$$\left. \begin{aligned} & K_1 P_i P^i + \\ & K_2 \left(\frac{(P_r;_s - P_s;_r)(P_L;_k - P_k;_L) g^{rl} P^s P^k}{P^i P_i} + \frac{(P^\lambda P_\lambda),_m (P^s P_s),_k g^{mk}}{P^i P_i} \right) + \\ & K_3 \left(\frac{(P^\lambda P_\lambda),_m P^m}{P^i P_i} \right)^2 + \\ & K_4 R \end{aligned} \right\} \sqrt{\pm g}$$

where: g is the determinant of the metric tensor, upper indices denote contravariant tensor property, lower indices denote covariant tensor properties, P_i denotes a gradient $P_i \equiv \frac{\partial P}{\partial x^i}$ of a gradually changing function P , that changes between the memory and input layers, $(-d < x^1 < d, -d < x^2 < d, \dots, -d < x^n < d)$, $(-d < x^1 < d, -d < x^2 < d, \dots, x^j + \delta, \dots, -d < x^n < d)$ (when n is the dimension of a Riemannian manifold and $d > 0$ is a very large in relation to $\delta > 0$), semi colon denotes a covariant derivative and comma denotes an ordinary derivative, $P_{i,j} \equiv \frac{\partial P_i}{\partial x^j}$. R denotes the scalar curvature also known as Ricci scalar, and K_1, K_2, K_3, K_4 denote constants of the model.

24. The apparatus of claim 21 further including means for ascertaining said representation of said input pattern by preprocessing said input pattern.

25. The apparatus of claim 21 further including means for ascertaining said representation of said memory pattern by preprocessing said memory pattern.

26. The apparatus of claim 21 wherein at least one of said initial values loaded into said cells in said intermediate layers are identical to said representation of said input pattern.

27. The apparatus of claim 21 wherein at least one of said initial values loaded into said cells in said intermediate layers are identical to said representation of said memory pattern.

28. The apparatus of claim 21 wherein means for comparing includes means for comparing said value in said cell with values in three adjacent cells in said adjacent layer.

29. The apparatus of claim 21 wherein said means for comparing includes means for calculating a distance in curved space from said cell in said intermediate layer to said cells in said intermediate layers.

30. The apparatus of claim 21 wherein said means for mapping cells includes means for introducing a vibration wave into a cell of said input layer.

31. An apparatus for comparing an input pattern with a memory pattern, the apparatus comprising:

means for loading a representation of said input pattern into cells in an input layer;

means for loading a representation of said memory pattern into cells in a memory layer;

means for loading an initial value into cells in an intermediate layers between said input layer and said memory layer;

means for comparing values of cells in said intermediate layers with values stored in cells of adjacent layers comparing values of cells in said intermediate layers with values stored in cells of adjacent layers through curved space;

means for updating values stored in cells in said intermediate layers in response to said means for comparing; and

means for mapping cells in said memory layer to cells in said input layer including introducing a vibration wave into a cell of said input layer.

32. The apparatus of claim 31 wherein said curved space is defined in Riemmanian geometry.

33. The apparatus of claim 31 wherein said means for comparing includes means for calculating a minimum energy connection in said curved space from said cells in said intermediate layer to said cells in said intermediate layers.

34. The apparatus of claim 33 wherein the minimum energy is written as:

$$\left. \begin{aligned} & K_1 P_i P^i + \\ & K_2 \left(\frac{(P_r;_s - P_s;_r)(P_L;_k - P_k;_L)g^{rl} P^s P^k}{P^i P_i} + \frac{(P^\lambda P_\lambda)_{,m} (P^s P_s)_{,k} g^{mk}}{P^i P_i} \right) + \\ & K_3 \left(\frac{(P^\lambda P_\lambda)_{,m} P^m}{P^i P_i} \right)^2 + \\ & K_4 R \end{aligned} \right\} \sqrt{\pm g}$$

where: g is the determinant of the metric tensor, upper indices denote contravariant tensor property, lower indices denote covariant tensor properties, P_i denotes a gradient $P_i \equiv \frac{\partial P}{\partial x^i}$ of a gradually changing function P , that changes between the memory and input layers, $(-d < x^1 < d, -d < x^2 < d, \dots, -d < x^n < d)$, $(-d < x^1 < d, -d < x^2 < d, \dots, x^j + \delta, \dots, -d < x^n < d)$ (when n is the dimension of a Riemannian manifold and $d > 0$ is a very large in relation to $\delta > 0$), semi colon denotes a covariant derivative and comma denotes an ordinary derivative, $P_{i,j} \equiv \frac{\partial P_i}{\partial x^j}$. R denotes the scalar curvature also known as Ricci scalar, and K_1, K_2, K_3, K_4 denote constants of the model.

35. The apparatus of claim 31 further including means for ascertaining said representation of said input pattern by preprocessing said input pattern.

36. The apparatus of claim 31 further including means for ascertaining said representation of said memory pattern by preprocessing said memory pattern.

37. The apparatus of claim 31 wherein at least one of said initial values loaded into said cells in said intermediate layers are identical to said representation of said input pattern.

38. The apparatus of claim 31 wherein at least one of said initial values loaded into said cells in said intermediate layers are identical to said representation of said memory pattern.

39. The apparatus of claim 31 wherein said means for comparing includes means for comparing said value in said cell with values in three adjacent cells in said adjacent layer.

40. The apparatus of claim 31 wherein said means for comparing includes means for calculating a Euclidean distance from said cell in said intermediate layer to said cells in said intermediate layers.